

## Chick provisioning by common terns in the southern Gulf of Maine, U.S.A.

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**Abstract:** We examined chick provisioning by common terns (*Sterna hirundo*) in relation to hatching order, chick stage, and weather on Stratton Island, Maine, U.S.A., during the summer of 1997. Provisioning rates, recorded at 10 nests during 30-min observation sessions ( $n = 256$ ), were calculated for first-, second-, and third-hatched chicks in three age-classes (1–5, 6–10, and 11–15 days). Mean provisioning rates did not differ significantly with hatching order of chicks. However, a trend toward differential provisioning was evident during the earliest chick stage. Mean provisioning rates increased significantly from age-class 1 to 2 and decreased significantly from age-classes 2 to 3. Weather had no significant effects on provisioning rates, owing to the unusually mild and consistent conditions. These results indicate that during the earliest chick stage, older siblings in a brood may have an advantage in obtaining food, even when weather conditions are highly favorable for provisioning chicks.

**Résumé :** Nous avons étudié l'alimentation des poussins par leurs parents chez la Sterne pierregarrin (*Sterna hirundo*) en tenant compte du rang des poussins dans la couvée, de leur stade de développement et des conditions climatiques dans l'île Stratton, Maine, É.-U., au cours de l'été de 1997. Les taux d'apport de nourriture à 10 nids au cours de sessions d'observation de 30 min ( $n = 256$ ), ont été calculés pour les poussins les premiers éclos, les seconds éclos et les troisièmes éclos, de trois classes d'âge (1–5, 6–10 et 11–15 jours). Les taux moyens d'apport de nourriture ne variaient pas significativement en fonction du rang d'éclosion des poussins. Cependant, nous avons observé une tendance à un approvisionnement différentiel au cours des premiers stades de vie des poussins. Les taux moyens d'apport de nourriture ont augmenté significativement entre les classes d'âge 1 et 2, et diminué significativement entre les classes d'âge 2 et 3. Les conditions climatiques étaient sans effet sur les taux d'approvisionnement et elles sont restées particulièrement clémentes et constantes durant les expériences. Les résultats indiquent qu'au cours des premiers stades, les poussins nés les premiers peuvent être avantagés quant à leur facilité à obtenir de la nourriture, même lorsque les conditions climatiques sont très favorables à l'approvisionnement.

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### Introduction

Common terns (*Sterna hirundo*) are piscivorous larids that breed in the temperate region of the northern hemisphere (Burger and Gochfeld 1991). These colonial seabirds typically lay 2 or 3 eggs, the third egg usually being the smallest and least likely to survive (Nisbet 1973). Partial incubation begins when the first egg is laid; consequently, hatching of eggs is asynchronous (Nisbet and Cohen 1975). During the first few days after hatching, females generally brood chicks

at the nest while males forage and provision the young (Nisbet 1973). Throughout the remainder of the chick stage, both males and females participate in feeding the young (Nisbet 1973; Wiggins and Morris 1987).

To date, no study has clearly elucidated chick provisioning by common terns in relation to hatching order of chicks (e.g., Langham 1972; Nisbet 1973; Wiggins and Morris 1987; Wiggins 1989; Frank 1992). This information is important for gaining insight into the phenomenon of differential survival of chicks within a brood that occurs as a consequence of asynchronous hatching (Bollinger et al. 1990).

Environmental factors are known to have a pronounced impact on prey-capture rates (Dunn 1973) as well as chick-provisioning rates (Langham 1972; Dunn 1975). However, many studies that have examined chick provisioning by common terns (e.g., Nisbet 1973; Wiggins and Morris 1987; Wiggins 1989) have failed to report weather conditions. The objectives of our study were to examine (i) chick provisioning by common terns in relation to hatching order and chick stage, and (ii) relationships between chick provisioning and weather conditions.

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**Table 1.** Weather categories and corresponding percentages for 256 thirty-minute observation sessions of 10 common tern nests on Stratton Island, Maine, U.S.A., during the summer of 1997.

	Category	% of total
Cloud cover	1 = $\leq 25\%$	47
	2 = 26–50%	17
	3 = 51–75%	14
	4 = 76–100%	22
Precipitation	1 = none	97
	2 = light rain	3
	3 = heavy rain	0
	4 = downpour	0
Visibility	1 = $< 100$ m	1
	2 = 100–500 m	2
	3 = 0.5–3.2 km	4
	4 = 3.2–10 km	23
	5 = 11–48 km	33
	6 = $> 48$ km	37
Wind speed	1 = 0–6 km/h (still air)	37
	2 = 7–24 km/h (light)	61
	3 = 25–32 km/h (moderate)	2
	4 = $> 33$ km/h (high)	0
Temperature	1 = 15–21°C	36
	2 = 22–27°C	49
	3 = 28–32°C	14
	4 = $> 32^\circ\text{C}$	1

## Methods

Our study was conducted from 20 June to 28 July 1997 on Stratton Island in the southern Gulf of Maine, U.S.A. (43°31'N, 70°19'W). The island, located 2.4 km off the mainland, is 13 ha in area and has diverse habitats including a small freshwater pond, a forest, and beaches of cobble and sand. During 1997, more than 800 pairs of common terns nested on this island and predation of nests was minimal (S.W. Kress, unpublished data).

Chick-provisioning rates (number of feeding bouts per 30 min) were recorded at 10 nests with three-chick broods during 30-min observation sessions ( $n = 256$ ). Observations were conducted daily at 3-h intervals during mornings and afternoons from three observation blinds. Nests were monitored for eggs and newly hatched chicks. Each nest was assigned a unique color and each chick was marked with a permanent fluorescent marker on or before day 2 of the chick stage. Hatching order of chicks was distinguished by marking first-hatched (A) chicks on the top of the head, second-hatched (B) chicks on the breast, and third-hatched (C) chicks on the back between the wings. Marks were reapplied as necessary throughout the study.

Ages of chicks were grouped into three classes (1–5, 6–10, and 11–15 days) based on the thermal independence and advanced locomotor capacity of chicks (Klaassen 1994). Mean provisioning rates of A, B, and C chicks were calculated for each age-class. A repeated-measures analysis of variance (ANOVA) was used to compare mean chick-provisioning rates by hatching order and age-class because multiple observations were made of individual chicks (Beal and Khamis 1990). Differences among means were interpreted using paired  $t$  tests.

Wind speed, visibility, precipitation, cloud cover, and ambient temperature were recorded during each 30-min observation ses-

sion. Wind speed and ambient temperature were recorded on a Davis Weatherwizard III computer located on the island and divided into four categories for analysis (Table 1). Visibility, precipitation, and cloud cover were visually estimated and also categorized (Table 1). Kruskal–Wallis tests were used to compare provisioning rates with weather variables because data did not meet the assumptions of ANOVA.

## Results

Mean provisioning rates of A, B, and C chicks did not differ significantly ( $F_{[2,27]} = 2.14$ ,  $P > 0.14$ ). However, a trend toward differential provisioning was evident during the earliest chick stage, as mean provisioning rates decreased with hatching order (Table 2). Mean provisioning rates did differ significantly among age-classes ( $F_{[2,54]} = 13.01$ ,  $P < 0.0001$ ). In age-class 1, mean provisioning rates were significantly less than in age-classes 2 and 3 (age-classes 1 vs. 2,  $P < 0.001$ ; age-classes 1 vs. 3,  $P < 0.01$ ). In age-class 2, mean provisioning rates were significantly greater than in age-class 3 (age-classes 2 vs. 3,  $P < 0.02$ ). There were no significant interactions between age-class and hatching order ( $F_{[4,54]} = 0.66$ ,  $P > 0.63$ ).

Weather conditions had no significant effects on chick-provisioning rates (all  $P > 0.05$ ). During this study, weather in the southern Gulf of Maine was unusually mild, with very little variability. Of the 256 observation sessions, 97% had no precipitation, 93% had visibility greater than 3.2 km, and 64% had cloud cover was less than 50% (Table 1). Precipitation records for Portland, Maine (the nearest weather station, 19.4 km from the island), indicated that June 1997 (1.97 cm) was the 5th driest on record since 1900, and July (5.11 cm) was the 23rd driest (National Oceanic and Atmospheric Administration 1997). In more than 97% of the observation sessions wind speeds were below 25 km/h. Temperatures were average at 17°C for June and 20°C for July (NOAA 1997).

## Discussion

To our knowledge the relationship between provisioning rates and hatching order of chicks has not been studied in common terns. Although we did not find any significant differences between provisioning rate and hatching order of chicks, we did observe a pattern of differential provisioning for the earliest chick stage (1–5 days), when mean provisioning rate decreased with hatching order. Differential provisioning during the earliest chick stage suggests that hatching asynchrony provides the older siblings in a brood with an advantage in obtaining food. Hatching asynchrony creates a size hierarchy among siblings (Bollinger et al. 1990), and may afford older siblings greater begging vigor.

Provisioning rates of chicks increased significantly from age-class 1 (1–5 days) to age-class 2 (6–10 days). This may be due to an increase in parental foraging as chicks mature (Klaassen 1994). Common tern chicks reach a developmental milestone at approximately 1 week of age, when they achieve a fairly stable level of thermal independence (Klaassen 1994). Thus, after a chick reaches 1 week of age, parental brooding time is reduced and parental foraging time is increased. This is supported by Wiggins and Morris (1987), who reported that mean provisioning rates of female

**Table 2.** Comparison of chick-provisioning rates (number of feedings per 30 min) for three age-classes (1 = 1–5 days, 2 = 6–10 days, 3 = 11–15 days) of first- (A), second- (B), and third-hatched (C) common tern chicks from 10 nests on Stratton Island, Maine, U.S.A., during the summer of 1997.

Hatching order	Age-class			Mean
	1	2	3	
A	0.72 (0.08)	1.00 (0.16)	0.82 (0.14)	0.85 <sub>a</sub> (0.13)
B	0.54 (0.08)	0.80 (0.10)	0.65 (0.06)	0.66 <sub>a</sub> (0.08)
C	0.36 (0.08)	0.85 (0.09)	0.62 (0.12)	0.61 <sub>a</sub> (0.10)
Mean	0.54 <sub>c</sub> (0.08)	0.88 <sub>a</sub> (0.12)	0.70 <sub>b</sub> (0.11)	

**Note:** Values are given as the mean, with the standard error in parentheses. Mean values followed by a different letter are significantly different (all  $P \leq 0.02$ ), within a row for age-classes and within a column for hatching order. See Results for  $F$  statistics and  $P$  values.

common terns increased by 80–90% after day 4 of the chick stage.

In our study, provisioning rates decreased significantly from age-class 2 (6–10 days) to age-class 3 (11–15 days). Wiggins and Morris (1987) also documented a general decrease in provisioning rates after day 10 of the chick stage. Total energy requirements of common tern chicks are estimated to peak around day 15 of the chick stage (Klaassen 1994). Thus, the decrease in provisioning rates found in our study suggests that the size of prey fish fed to chicks increased later in the chick stage. This habit of delivering increasingly larger fish to growing chicks has been reported for common terns (Wiggins and Morris 1987), as well as for roseate terns (*S. dougallii*) and sandwich terns (*S. sandvicensis*) (Shealer 1998).

Weather conditions had no significant effects on provisioning rates, probably because of the unusually mild and consistent weather patterns during the study period. Mild temperatures coupled with little precipitation (Klaassen 1994) and persistent light winds (Dunn 1973; Taylor 1983) are conditions considered favorable for chick provisioning in common terns. Because these conditions prevailed throughout our study, provisioning rates may have been at or near optimal levels. As a result, differences in provisioning within a brood may have been minimized. Thus, the trend toward differential provisioning in age-class 1 may have been more pronounced if weather conditions had been harsher.

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